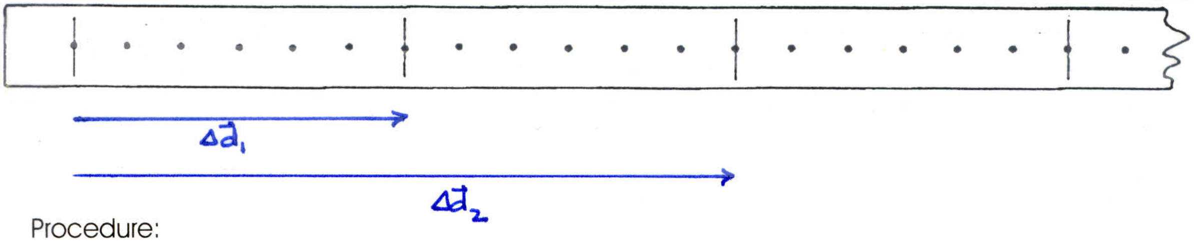
LAB ACTIVITY – ANALYZING THE MOTION OF AN OBJECT

We are creatures that are fascinated by how fast things move. We love the thrill of NASCAR where cars reach close to 300 km/h. Light travels at an astonishing 300 million metres per second while glaciers travel approximately 3-6 metres per year. Continents drift at a rate of less than 2 cm per year.

In order to determine the velocity of an object we require information about its displacement and time of travel. Measuring displacement in the lab is easy – a metre stick will often do the trick. Measuring time over short intervals using a stopwatch presents a problem... our reaction time often interferes with the outcome.

One device often used to measure small time intervals is the *ticker-tape timer.* The timer consists of a vibrating hammer, a metal target, a carbon paper disc placed face down on the target, and a long strip of recording tape (ticker tape). As the object moves, it pulls the tape between the metal target and the carbon disc. A dot is made on the tape every time the hammer strikes. This occurs at a rate of 60 dots per second or six dots every 1/10th of a second. With this set up, we can measure displacement and time accurately. Below is an example of such a recording.



Procedure:

1. For Part A of the lab, a string with a paper clip attached at one end is attached to a cart. The paper clip end of the string is placed over a pulley. A small washer is hung on the paper clip. It acts as a counterweight in order to reduce the effects of friction (friction tends to make the cart slow down and stop).

2. The cart, placed at the far end of the track, is given a push. If the cart slows down, additional washers are added until it moves smoothly.

3. Once you are confident that the cart travels smoothly, re-position the cart at the far end of the track and measure the distance of the washers to the floor. Obtain a piece of ticker-tape slightly smaller than this distance and attach one end to the cart; feed the other end through the ticker-tape timer.

4. Give the cart a slight push and, very soon after it is moving, have your partner start the timer. Stop the timer when the tape has completely travelled through the timer. Label this tape "Part A" where the first set of dots were created.

5. For part B of the experiment, replace the washers with the hanging mass provided. Attach the necessary amount of tape to the cart and feed it through the timer. Once you let go of the cart at the far end of the track, start/stop the timer as in step 4. Label this tape "Part B"

6. In order to extract the necessary information from each tape, lay the tape flat on the table. It will help to, uhm, tape the tape down.

   - ☐ Circle the first dot and label it zero.
   - ☐ Count six dots thereafter; circle the 6^{th} dot and label it "1"
   - ☐ Keep going, labelling every 6^{th} dot: 2, 3, 4, etc.
   - ☐ Every circled dot represents a 0.10 second time interval. Therefore, the total time elapsed at the first circle is 0.10s; at the second circle, 0.20s, etc.
   - ☐ Record the total elapsed times as well as the corresponding total displacements in the table provided.

Observations:

Table 1 Position-time data for Part A of the experiment

Elapsed time (s)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Displacement (cm)	0.0									

Table 2 Position-time data for Part B of the experiment

Elapsed time (s)	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Displacement (cm)	0.0									

Analysis:

For each set of data, plot a position-time graph. Be sure to label each axis appropriately. Then, in essay form, address each of the points below:

- ☐ What did this investigation study?
- ☐ What does the first graph (Fig. 1) illustrate? Do the results support an object moving uniformly? Explain. What was the velocity of the object?
- ☐ What is average velocity? How is it determined? What was the average velocity of the cart in part A? Why is the answer the same / different as the velocity determined earlier?
- ☐ What is instantaneous velocity? How is it determined? What is the instantaneous velocity of the cart at t=0.45 s? Is it the same / different to the velocity determined earlier? Explain.
- ☐ Repeat the above analysis but this time for part B (Fig. 2)
- ☐ Research and report on how one would go about determining the acceleration of the object in part B.
- ☐ Submit your observations and discussion (analysis).

POST-LAB QUESTION

Two position-time graphs are shown below. Clearly describe the motion of each object, performing any calculations wherever necessary.